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GEOLOGY.—*Notes on the igneous rocks of the northeast West Indies and on the geology of the Island of Anguilla.*[1] THOMAS WAYLAND VAUGHAN, Scripps Institution of Oceanography, La Jolla, California.

The following paper consists of notes on a collection of igneous rocks I made in the West Indies in 1914, with determinations of the different rock specimens by the late Prof. J. P. Iddings, and of supplemental notes on the geology of the Island of Anguilla.

IGNEOUS ROCKS AND A FEW ASSOCIATED SEDIMENTS FROM THE LEEWARD AND VIRGIN ISLANDS

Before Professor Iddings' lamented death he examined and identified for me all the samples of igneous rocks I collected in the West Indies in 1914. After his death that collection and other specimens were sent to Dr. E. O. Hovey, who was making a general study of the volcanic rocks of the eastern West Indies. Since Doctor Hovey died before completing his investigations, it appears desirable to publish an annotated list of the rocks with Professor Iddings' determinations.

The only explanatory remark needed seems to be regarding L. I. 56, 58, and 60, from St. Bartholomew. The contact of the rock represented by these samples with the St. Bartholomew limestone was not seen. The presence below the St. Bartholomew limestone of pebbles (L. I. 54) of rock similar to the rock referred to by the numbers just mentioned suggests an age greater than that of the limestone, but L. I. 64, 65, and 66 represent rock obviously intruded into the limestone.

The geologic ages of the formation mentioned in the column headed "Geologic Occurrence" are as follows: Antigua formation, upper and middle Oligocene; St. Bartholomew, upper Eocene; Anguilla formation, lower Miocene.

[1] Received June 15, 1926.

LIST OF ROCKS FROM THE NORTHEASTERN WEST INDIES. DETERMINATIONS BY J. P. IDDINGS

LOCALITY (FIELD) NUMBER	STATION NUMBER	NAME OF ROCK	LOCALITY	GEOLOGIC OCCURRENCE
L. I. 18		Altered dacite or rhyolite	Antigua, Rat Island, north side, alt. 30–40 ft.	Bedded tuff, older than the Antigua formation
L. I. 19		Basalt	Antigua, N. 18°E. from Langford Mill on slope of first ridge to the north towards Crosby's Mill	Intrusive into the Antigua formation
L. I. 32		Dacite tuff	Antigua, eastern slope of hill at Bethesda Church, head of Willoughby Bay	Bedded tuff, older than the Antigua formation
L. I. 38		Dacite tuff	Antigua, north of All Saints Bridge, 4¼ miles from St. John	Older than the Antigua formation
L. I. 39		Holocrystalline andesite	Antigua, summit of Drew's Hill	Younger than the Antigua formation
L. I. 40		Altered andesite, brecciated	Antigua, Drew's Hill 110 ft. below the summit	Younger than the Antigua formation
L. I. 44		Possibly microcryptocrystalline silica	Antigua, top of Gray's Hill	Bedded rock occurring with the bedded tuff; older than the Antigua formation
L. I. 47		Altered andesite	Antigua, northeast foot of Montero Hill	Not definitely ascertained, probably younger than the Antigua formation
L. I. 50		Altered basalt	Antigua, between Orange Valley and Church Bay, behind first hill back from the shore	Not definitely ascertained, probably younger than the Antigua formation
L. I. 51		Altered dacitic rock	Antigua, west side of Burnfoot Hill	Appears to be younger than the Antigua formation
L. I. 55	6882	Much altered andesitic tuff	Antigua, English Harbor Village, east side of Falmouth Harbor	Not definitely ascertained
L. I. 56b	6883	Andesitic tuff	Antigua, Falmouth Harbor, slope of Monk's Hill, alt. about 100 ft.	Younger than the Antigua formation
L. I. 56c	6884	Altered andesitic glass	Same locality as L. I. 56b, but on top of the hill	Overlies L. I. 56b, therefore younger
L. I. 58[1]	6885	Altered tuff	Antigua, west and south slope of Monk's Hill	Unconformably overlies water-bedded tuff

LOCALITY (FIELD) NUMBER	STATION NUMBER	NAME OF ROCK	LOCALITY	GEOLOGIC OCCURRENCE
L. I. 59[I]	6886	Altered andesitic glass	Antigua, Barnabas	Seems to belong to the tuffs older than the Antigua formation
L. I. 54[II]	6895	Altered pyroxene andesite	St. Barts, spur s.e. side of Anse Écaille Bay; alt. 120 ft.	Pebbles from conglomerate interbedded with St. Bartholomew limestone
L. I. 56[II]	6896	Holocrystalline pyroxene andesite	St. Barts, northwest end of point on which Ft. Gustaf stands, alt. about 20 ft.	Not definitely ascertained; seems older than Eocene St. Bartholomew limestone
L. I. 58[II]	6898	Altered pyroxene	St. Barts, above Ballast Bay; alt. 430 ft.	Probably the same as L. I. 58[II]
L. I. 59[II]	6899	Altered pyroxene andesite	St. Barts, slope of divide between Carasol and Flammand bays, Carasol Bay side; alt. 210 ft.	Apparently intruded into the St. Bartholomew limestone
L. I. 60	6900	Holocrystalline pyroxene andesite	St. Barts, between Carasol and Flammand bays, Carasol Bay side of divide; alt. 100 ft.	Seems to be older than the St. Bartholomew limestone
L. I. 61	6901	Altered andesite	St. Barts, south slope of divide up from Carasol Bay, alt. 130 ft.	Apparently the same as L. I. 59[II]
L. I. 65	6906	Micro-quartz diorite or holocrystalline quartz-pyroxene andesite	St. Barts, northwest side of head of Galet Bay; alt. 140 ft.	Intruded into St. Bartholomew limestone. The same as intrusion L. I. 64
L. I. 67	6908	Altered pyroxene andesite	St. Barts, head of Marigot Bay; just above sea level	Not ascertained
L. I. 68	6909	Altered pyroxene andesite	St. Barts, east end of island; Tortue bearing N. 15°E., Grand Fond Mountain bearing S. 55°W.	Not ascertained
L. I. 69	6910	Altered pyroxene andesite	St. Barts, Grand Fond Bay; alt. 60 ft.	Not ascertained
L. I. 70	6911	Altered aphanitic dacite?	St. Barts, south slope of La Croix Mountain	Not ascertained
L. I. 71	6912	Altered aphanitic dacite? Similar to L. I. 70	St. Barts, Brim Mountain, north slope	Not ascertained

LOCALITY (FIELD) NUMBER	STATION NUMBER	NAME OF ROCK	LOCALITY	GEOLOGIC OCCURRENCE
L. I. 72[a]	6913	Altered andesite or dacitic tuff	St. Barts, L'Orient Point; the basal bed	Underlies L. I. 72b
L. I. 72[b]	6914	Altered dacitic ? tuff	St. Barts, L'Orient Point; bed next above L. I. 72a	Overlain by St. Bartholomew limestone
L. I. 73	6916	Altered andesitic tuff	St. Barts, L'Orient Bay, base of point on west side	Underlies St. Bartholomew limestone
L. I. 74	6917	Altered andesitic tuff	St. Barts, L'Orient Bay, east half, south side of bay	Underlies St. Bartholomew limestone
L. I. 77	6920	Altered mica-bearing andesite	St. Barts, Gouverneur Bay, west cove	Intruded as dike into St. Bartholomew limestone
L. I. 79	6922	Dacite	St. Barts, volcanic peak, east side of Gouverneur Bay	Younger than St. Bartholomew limestone. Compare with L. I. 70 and L. I. 71
L. I. 84	6927	Altered pyroxene andesite	St. Barts, Anse Lézard, boulder in volcanic agglomerate and conglomerate	Appears to lie below the Bartholomew limestone
L. I. 80	6931	Altered pyroxene andesite	St. Barts, south of south east corner of Bay Flammand, n.e. side of main divide of the island	Intruded into the St. Bartholomew limestone
L. I. 89	6932	Altered andesite, possibly dacite	St. Barts, col between St. Jean and Chauvette bays	Probably younger than the St. Bartholomew limestone. Compare this with L. I. 70, L. I. 71, and L. I. 79. Seems to me (T. W. V.) the same as L. I. 71 and L. I. 79
L. I. 90	6955	Altered tuff	St. Martin, south of Red Hill, near Simson Bay	Post-Miocene
L. I. 91	6956	Laminated sediment	St. Martin, Petite Écaille Bay, west of North Point	Probably Cretaceous
L. I. 92	6957	Holocrystalline dacite	St. Martin, Grande Écaille Bay, south of North Point	Post-Cretaceous
L. I. 93	6959	Micro-quartz-dacite or holocrystalline pyroxene andesite	St. Martin, west side of head of Cul de Sac Bay, Well's lodge	Post-Cretaceous

LOCALITY (FIELD) NUMBER	STATION NUMBER	NAME OF ROCK	LOCALITY	GEOLOGIC OCCURRENCE
L. I. 95	6961	Finer grained, like L. I. 93	St. Martin, head of Orient Bay, Orient Bay side of divide between it and Grand Case Bay; from a pit	Post-Cretaceous
L. I. 108	6945	Fine-grained granite or quartz monzonite	St. Martin, east side of Grand Bay, southwest foot of peak 634 ft. high	Post-Cretaceous; intruded into L. I. 109
L. I. 109	6946	Banded metamorphosed sediment	Same locality as L. I. 108	Probably Cretaceous: intruded by L. I. 108
L. I. 110	6947	Fine-grained quartz diorite	Same locality as L. I. 108	Intruded into sediment L. I. 109; specimen taken back from contact. L. I. 108 the dike form of this rock
L. I. 111	6948	Altered andesite	St. Martin, east side of Ft. Amsterdam Hill	
L. I. 113	6950		St. Martin, Philipsburg-Marigot road, neck of land at southeast corner of Marigot Bay	Intruded into sediments probably of Cretaceous age
L. I. 114	6951	Altered andesite	St. Martin, Philipsburg-Marigot road; out of well east of Simpson Lagoon	Not observed, probably post-Cretaceous
L. I. 99	6975	Altered andesitic tuff	Anguilla Crocus Bay, Pelican Point	Unconformably overlain by the Anguilla formation
L. I. 102	6969	Altered basalt	Anguilla, Road Bay, north side, near western end of point of land on N. side of bay	Unconformably overlain by the Anguilla formation
L. I. 9		Pyroxene andesite	St. Kitts, Brimstone Hill N. side; alt. 360 and 460 ft.	Probably post-Pleistocene in age
L. I. 10		Pyroxene andesite	St. Kitts, 2¼ mi. from Basseterre on road to Old Road	Broken from a large boulder; geologic relations not observed
L. I. 5		Altered andesitic tuff	St. Croix, Frederiksted, Fort Catarhina Hill	Apparently overlain by hard limestone.[a]
L. I. 1		Altered andesite	St. Thomas, ½ mi. S. E. of Frederiksberg, half way between Frederiksberg and Flag Hill	Not observed. This rock is mapped as "bluebeach" by Cleve

[a] In this limestone are included pieces resembling L. I. 5. The limestone seems to be of Middle Oligocene age.

A considerable volume of literature is now available on the igneous rocks of the West Indies. Papers by Högbom,[2] Calkins,[3] Earle,[4] Fittke,[5] and Burbank,[6] are listed below, but these references do not exhaust the literature. I made in the Virgin Islands of the United States a considerable collection of igneous rocks which were examined by Mr. Clyde P. Ross of the U. S. Geological Survey but no report was finished for publication. I have published a few notes on these rocks in the papers cited below.[7] I collected all the kinds of rocks mentioned by Mr. Earle in his paper on the Virgin Islands except pegmatite.

No review of present knowledge West Indian igneous rocks can be attempted in this article, but a few general remarks may be made. One of the striking features of the West Indian rocks is the persistence of rocks of the diorite-andesite group, with or without free quartz, virtually throughout all the known geologic ages. They extend from the probably Paleozoic Daguilla diorite schist of the Isle of Pines[8] to the modern andesitic lavas of St. Kitts. A striking feature of the rocks is the almost complete absence of potash feldspars. This is only corroboration of what Högbom has so well expressed in his paper. The only rocks among those I collected and listed above which contains potash in a notable amount is my L. I. 109, on the east side of Grande Bay, St. Martin.

More basic rocks are also well developed in the West Indies; peri-

[2] HÖGBOM, A. G., *Zur Petrographie der kleinen Antillen.* Geol. Inst. Upsala Bull., **6**: (pt. 2), 214–232, *pls. 9, 10*, 1905.

[3] CALKINS, F. C., *Metamorphic and igneous rocks*, in Geol. Reconn. Dominican Repub., by T. W. Vaughan and others, Geol. Surv. Dominican Repub., Mem., **1**: 83–88, 1921. Also in Spanish edition.

[4] EARLE, K. W., *Report on the geology of Antigua*, Govt. Printing Office, Leeward Ids., 1923. 28 pp.

—— ——, *The geology of the British Virgin Islands*, Geol. Mag., **61**: 339–351, 1924.

—— ——, *Reports on the geology of St. Kitts-Nevis, B. W. I., and the geology of Anguilla, N. W. I.*, Published by the Crown Agents for the Colonies, London. Pp. 50.

[5] FITTKE, C. R., *The geology of the Humacao District, Porto Rico*, N. Y. Acad. Sci. Scientific Survey of Porto Rico and the Virgin Ids., **2**: (pt. 2) 117–197, text-figs., and map, 1924. (Much other information has been published by the N. Y. Acad. Sci., see bibliography of this paper.)

[6] BURBANK, W. S., *Igneous rocks, Geology of the Republic of Haiti*, by W. P. Woodring and others, pp. 260–330, 1924. Repub. Haiti, Dept. Public Works. Also in French edition.

[7] VAUGHAN, T. W., *Stratigraphy of the Virgin Islands of the United States, etc.*, THIS JOURNAL **13**: 303–317, 1923. (In the bibliography at the end of this paper I failed to list the very important paper by Professor Högbom, for which see foot-note 2 of this paper.) *A sketch of the history of igneous activity in the northern and north-eastern West Indies*, Third Pan-Pacific Science Congress, Australia, 1923, Proc., **1**: 851–55, 1925.

[8] HAYES, C. W., Report on a geological reconnoissance of Cuba, Rept. of the Military Governor for 1901, p. 115, 1902.

dotites, usually metamorphosed into serpentine, gabbro, and several kinds of basalts are known.

Regarding the igneous rocks of Anguilla, Mr. Earle says:

> The igneous rocks forming the basement beds of Anguilla and Dog Island do not differ essentially from those forming the foundations of St. Kitts and Antigua to the south and are all parts of the Antillean "province" as distinct from the very different suite of igneous rocks forming the Virgin Island "province."

As regards the similarity of the mode of occurrence of the igneous rocks in Anguilla to those in Antigua Mr. Earle is right, but there are andesites and dacites of probably Triassic or Jurassic age in Haiti; andesites and andesitic tuffs of Cretaceous age occur in St. Thomas and probably in St. Croix; and andesitic tuffs are interbedded with Eocene sediments in St. Bartholomew. In Cuba, in the Province of Santa Clara, quartz diorite underlies Upper Cretaceous sediments; dioritic rocks are intruded into Cretaceous sediment in St. Thomas, Culebra, Vieques, and elsewhere; in St. Bartholomew holocrystalline andesite is both older and younger than the Eocene sediments; in Haiti quartz diorite is intruded into Eocene sediments. Igneous rocks of the chemical composition indicated extend in age from pre-Cretaceous to present time in the West Indies. Gabbro and basalt have about the same geologic range but do not occupy so large areas. Peridotite and serpentine are extensively present in Cuba, the Dominican Republic, and Porto Rico, and are present in the republic of Haiti. They are mostly of Mesozoic age.

NOTES ON THE GEOLOGY OF ANGUILLA

Some months ago I received a copy of Mr. Kenneth W. Earle's paper entitled "The Geology of Anguilla, B. W. I.,"[9] in which he says that he does not understand a generalized, composite section I published[10] of the exposures adjacent to Crocus Bay and he disagrees with my statement that the Anguilla formation rests on igneous rock at Crocus Bay.

My original characterization of the Anguilla formation is as follows:[11]

> *Anguilla formation.* This formation is uppermost Oligocene, if the Aquitanian of Europe is correctly referred to the Oligocene. In the opinion of some paleontologists it would be classified as earliest Miocene. It is paleontologically characterized by certain Foraminifera, described by J. A.

[9] Published by the Crown Agents for the Colonies, 4, Millbank, London, S. W. 1, without date.

[10] U. S. Nat. Mus. Bull., **103**: 262, 1919.

[11] THIS JOURNAL, **8**: 271, 1918.

Cushman in a report not yet published; by numerous species of corals, among which are the genera *Stylophora, Stylocoenia, Antillia, Orbicella, Siderastrea,* and *Goniopora;* by echinoids described by Guppy or by Cotteau, among which are *Echinolampas semiorbis* Guppy, *E. lycopersicus* Cotteau, and *Agassizia clevei* Cotteau; and by a number of species of Mollusca, described in manuscript by C. W. Cooke. The Mollusca include *Amusium lyonii* Gabb and *Orthaulax pugnax* (Heilprin). I obtained no specimens of *Lepidocyclina* in Anguilla. The type exposure is along the southeast and south shore of Crocus Bay. The material consists of calcareous clay, argillaceous limestone, and more or less pure limestone. The formation unconformably overlies basic igneous rock.

Mrs. Burdon reprinted the paragraph quoted above, accompanied by a few notes I gave her on Anguilla, in her useful little volume entitled "A Handbook of St. Kitts-Nevis, a Presidency of the Leeward Islands Colony, containing information for residents and visitors concerning the Islands of St. Christopher or St. Kitts, Nevis and Anguilla."[12]

The description of the generalized section mentioned above which I published reads as follows:

GEOLOGIC SECTION AT CROCUS BAY, ANGUILLA

3. Hard cavernous limestone, with few or no corals	60 feet
2. More or less argillaceous limestone with some beds of harder, purer limestone; contains fossil corals from bottom to top, some coral heads as much as 2 feet in diameter; this member subdivisible into subordinate beds, about	200 feet
1. Yellow and brownish clay underlain by dark blue-black clay, or by sandstone and conglomerate of igneous material, overlying basic igneous rock (exposed at Pelican Point)	5 feet

I have discussed some of the geological features of Anguilla in other papers listed below.[13]

[12] Published by authority of the Government of St. Kitts-Nevis by the Crown Agents for the Colonies. London, The West India Committee, 1920, see pp. 232, 233.

[13] *The platforms of barrier coral reefs,* Amer. Geogr. Soc. Bull., **46:** 427–428, 1914.

Studies of the stratigraphic geology, etc., of several of the smaller West Indian Islands, Carnegie Inst. of Washington, Yearbook for 1914, pp. 13, 14, 1915.

Some littoral and sublittoral physiographic features of the Virgin and northern Leeward Islands and their bearing on the coral reef problem, THIS JOURNAL, **6:** 61, 62, 1916. Abstract in Geol. Soc. Amer. Bull., **27:** 44, 1916.

Fossil corals from Central America, Cuba, and Porto Rico, etc., U. S. Nat. Mus. Bull., **103:** 209, 262, 276, 277, 1919; *The biologic character and geologic correlation of the sedimentary formations of Panama, Ibid.,* p. 585.

Correlation of the Tertiary formations of Central America and the West Indies, First Pan-Pacific Sci. Congress Proc., Bishop Mus. Special Pub., pp. 832, 833, 1921.

Stratigraphic significance of the West Indian species of fossil Echini, Carnegie Inst. Washington, Pub., **306:** 113, 114, 1922.

Criteria and status of correlation and classification of Tertiary deposits, Geol. Soc. Amer. Bull., **35:** 733, 1924; *American and European Tertiary larger foraminifera, Ibid.,* 803.

During 1914 I spent nearly two months in geological field work in the northeastern West Indies and I was in Anguilla from February 28 until March 8. While on the island I made careful studies of the exposures along and near the shores of Crocus Bay and less detailed studies of very nearly the entire island, but I did not visit the outlying islands. Some of these were viewed through field glasses and Mr. Carter Rey gave me a number of notes on them. Since the exposures in Anguilla, especially those in the vicinity of Crocus and Road Bays, are of much importance in the study of the West Indian Tertiary formations, it seems desirable to present more detail than has hitherto been published.

No general description of the physical features of the Island will be given here, since such descriptions are available in several papers, the earliest with which I am acquainted being "Reports on the Geology of Jamaica" by Sawkins and others, 1869. The description in the British Admiralty's "West India Pilot," vol. 2, pp. 289–296 is good. The general map of Anguilla I have used is chart no. 1834 of the Hydrographic Office, U. S. Navy, which is based on a British Survey made in 1847 and subsequent small corrections. A detailed chart of Crocus Bay is published as one of several harbor charts on chart no. 371*a* of the Hydrographic Office, U. S. Navy. This chart is based on British surveys made in 1846, corrected to 1883.

Crocus Bay lies on the northwest side of Anguilla between two points of land of which the more southern projects farther west than the one at the north. The extreme distance across the harbor opening is about 1.9 sea miles. The maximum distance from a line between the seaward ends of the bounding points to the bay shore is about 0.8 sea mile. The bay is open toward the west. The end of the northern point is known as Flat Cap. The sea between slopes gradually from a depth of 9 fathoms in the outer part of the bay to the shore.

The highest land adjacent to Crocus Bay is at the Customhouse, whose altitude is 218 feet above sea level. From Valley Postoffice, where the bay extends farthest into the land, there is a gradual slope to sea level from an altitude of about 140 feet. Most of the slopes around the bay are steep, even precipitous. The Customhouse stands only about 800 feet back from the water's edge according to the chart, the slope there being almost 1 foot in 4 feet.

The following description of the section exposed between the Customhouse and the water's edge at Crocus Bay is a composite,

since all of the section could not be seen in one continuous bluff face or slope. The lower 6 beds were examined along the foot of the bluff and in its northeastern part on the south side of the slope from Valley Postoffice to the shore of the bay. At a height of about 90 feet above sea level the line of the section was shifted southward to a steep-faced bluff which rises to a height of about 185 feet above sea level. Several aneroid barometer readings gave the height of the top of the bluff above sea level as between 175 and 200 feet, which is too low, the actual height by the chart being 218 feet. A correction has, therefore, been applied to the aneroid readings in order to make the thickness of the beds equal the height of the bluff. The measurements are only approximate. The exposures along the southeast shore of the Bay are nearly along the strike of the beds, which is southwestward; the dip is southeastward, at an angle of perhaps 10°—precise measurement is not practicable.

DESCRIPTION OF SECTION ON THE SOUTHEAST SHORE OF CROCUS BAY, NEAR VALLEY POSTOFFICE (THICKNESSES ONLY APPROXIMATE)

	Thickness in feet
8. Limestone, massive, hard, exposed at the Customhouse, 218 feet above sea level; overlies the coralliferous limestone and marls exposed below.	
7. Limestone, yellowish, argillaceous, with interbedded harder limestone which forms discontinuous beds or bands. A large number of corals and some echinoids were collected from exposures equivalent in stratigraphic position to the upper half of this part of the section, field no. L. I. 96 (1914). About 40 ft. above the base of this division corals, three species of echinoids, *Amusium*, *Spondylus*, etc., were collected field no. L. I. 100*c* (1914)	130
6. Limestone, harder, but with considerable clay, colored yellowish to red with oxides of iron	12
5. Limestone, more argillaceous, zones of nodular limestone in clay; many corals, some excellently preserved, part of collection field no. L. I. 100*b* (1914)	30
4. Limestone, harder, base of the *Echinolampas semiorbis* bed, corals abundant, part of collection field no. L. I. 100*b* (1914)	12
3. Yellowish calcareous clay and yellowish argillaceous limestone. Much of the more calcareous parts form more or less nodular bands embedded in more argillaceous matrix. Fossils are abundant in this part of the section: *"Orbitolites," Miogypsina antillea*, *Stylophora*, *Orbicella* (heads 2 ft. in diameter), *Goniopora* (heads 2 ft. in diameter), *Porites*, some echinoids, *Ostrea*, *Pecten*, *Spondylus*, *Turritella*, etc. In some places *Miogypsina antillea* makes up most of the rock. Collection field no. L. I. 100 (1914) mostly from the lower part; field no. L. I. 100*a* (1914) solely from lower 10 ft. of this division	30
2. Yellowish, brownish, and chocolate-covered clay	3
1. Base of bluff. Blue-black clay in which lignite and amber have been found. This corresponds to the bed immediately overlying the volcanic sandstone and conglomerate and andesitic tuff on the north side of the bay	2
Total thickness, approximately	219

On the north shore of Little Harbor, northern part of Crocus Bay, near Flat Cap Point, there is the following exposure:

SECTION, LITTLE HARBOR, CROCUS BAY

	Thickness in feet
3. Hard, massive, cavernous limestone, many caves, some 50 ft. in depth. From a pit in one of them Mr. Carter Rey collected specimens of *Amblyrhiza*	60
2. Laminated calcareous sandstone	15
1. Argillaceous yellow limestone with many fossil corals, especially branching poritids	20

There has been much faulting between Flat Cap and Pelican Point, as noted by Mr. Earle, and the dips are greatly disturbed. I made no attempt to unravel the details of the faulting, although several records of the strike of the fault lines and the direction of the downthrow were made.

I interpret the hard cavernous limestone in the bluff on the north side of Little Harbor as representing the same horizon as that at the Customhouse. This limestone is no. 3 of my section quoted on page 352 of this article and its thickness is set down as 60 feet. The "60" should be followed by a plus sign. At Sandy Hill, east of Forrest, similar hard limestone overlies argillaceous coralliferous limestone. No. 2 of the section quoted includes beds nos. 3 to 7 of the more detailed section of the bluff below the Customhouse; and no. 1 of the quoted section includes nos. 1 and 2 of the section here given. I made extensive collections from member no. 3 of the generalized section, and the different collections were labeled and given field numbers, the height above sea level of the different lots being indicated on the labels. All of the material I obtained has been described and the descriptions published except for some of the corals. I described a part of the corals and discussed the ensemble of the coral fauna in U. S. Nat. Mus. Bull. 103. The beds between the underlying volcanic sandstone and andestic tuff and the base of the overlying hard cavernous limestone, no. 3 of the generalized section, belong to the Anguilla formation. I am not certain of the classification of the uppermost limestone but incline toward including it in the same formation.

Regarding the kind of rock on which the Anguilla formation rests at Pelican Point a note in my notebook reads as follows:

Pelican Pt. bedded agglomeratic sandstone and conglomerate. Material averages coarser toward the base and finer toward the top, but beds of finer and coarser material alternate; grades into clayey material at the top; underlies the limestone. Strike north and south; dip eastward, 35°. Field no. L. I. 99 (1914). This material is similar to that which underlies the limestones in both St. Barts and St. Martin.

The beds here are disturbed, as pointed out by Mr. Earle. The material I collected at Pelican Point was submitted to the late Prof. J. P. Iddings for determination and he pronounced it "altered andesitic tuff." If in my papers I had said that the clays forming the basal part of the Anguilla formation rested on the eroded surface of an altered andesitic tuff instead of "basic igneous rock" my statement would have been precisely instead of approximately correct. Professor Iddings determined my specimens (field no. L. I. 102, 1914) of igneous rock from Road Bay as "altered basalt."

I shall not discuss the propriety of calling an andesitic tuff an igneous rock, but I shall say that tuffs interbedded with sedimentary rocks are common in the West Indies and in many instances it is not easy to decide whether the rocks should be classified as sedimentary or volcanic rocks. Since Mr. Earle says "These lowest beds contain abundant angular fragments of volcanic rock of andesitic type and evidently represent the first epoch of submergence of the igneous rocks below the sea prior to the deposition of the limestone" his opinion does not differ substantially from what I had already published.

The general section at Road Bay is so similar to that exposed at Crocus Bay that a detailed description of it is unnecessary.

I now think that the Anguilla formation may be of Langhian (Burdigalian) instead of Aquitanian age. (See my 1924 papers.) Besides their bearing on problems of stratigraphic geology, the Anguilla formation and its geological relations are of interest because of the evidence they supply on the conditions under which coral-reef limestones form. I think J. W. Spencer correct in regarding the formation as "a part of the coastal plain extending from the mountains of St. Martin."[14] The deposit in Anguilla was laid down some distance offshore, it rests unconformably on a basement of volcanic rock, and the amount of submergence indicated by the thickness of the formation exceeds the depth at which the kinds of corals found in it thrive. The reef corals grew up on a basement which subsided to a depth greater than that at which reef corals live but without interrupting the continuity of reef formation. The reef was probably of the barrier type, although the lagoon may later have been filled and limestone with few or no corals laid down over the reef.

J. W. Spencer postulates the presence of a limestone of late Pliocene age over the Anguilla formation, from which it is separated by an unconformity, but I doubt the correctness of this interpretation, since

[14] Geol. Soc. London Quart. Journ., 57: 520–533, 1901.

the dip of the lower beds as given by SPENCER, 40° northeastward, is a disturbed dip and the higher more nearly horizontal limestone probably does not rest directly on beds with such discordance in dip. Mr. Earle says:

> At some points on the east side of Crocus Bay and eastwards along the coast from Flat Cap there is very fine-grained coral limestone unconformably overlying the Oligocene beds and dipping steeply (as much as 30°) west, i.e., towards the sea. This is a very soft, fine-grained material without megascopic fossils, consisting essentially of very finely comminuted fragments of coral rock. Its very marked flaggy bedding is more apparent than real, for the rock will not split along the bedding planes, breaking only with an irregular fracture. A very fine exposure of this rock is seen two miles northeast of Island Harbour, and is evidence of the very important uplifts that have affected the island in (geologically) recent times.

Although I should not be justified in denying the presence of a very young limestone unconformably overlying the Miocene deposits, I doubt the correctness of the interpretation of both Spencer and Earle. I examined on the northeast side of Pointe Blanche, St. Martin, an exposure of flaggy calcareous sandstone which overlies the older, probably Cretaceous, flaggy sandstones and shales, and appears to be a Pleistocene or younger deposit that has been uplifted about 20 feet. I saw no deposit of this kind in Anguilla.

Evidence of geologically recent subsidence in Anguilla has been presented in several of my papers. I have published descriptions and profiles of the submarine terraces, descriptions of the bays and the bay bars, and descriptions with an illustration of the enclosed ponds, the bottom of several of which are reported to communicate with the sea.[15] Mr. Earle mentions "the underground communication between enclosed basins in the limestone and the sea."[16] He attributes the "beaches across the mouths of the coastal inlets" to elevation. The formation of the bay bars is due primarily to submergence, which produced a bay, across the mouth of which a bay bar later formed. I am not sure whether or no there has been a minor emergence in the West Indies similar to that described for Samoa by Daly and for the Hawaiian Islands by Wentworth and Palmer. It appeared to me that there probably had been such an emergence in Antigua and perhaps in St. Bartholomew, but the evidence was not entirely conclusive. A more detailed study was needed than I was able to make

[15] U. S. Nat. Mus. Bull., **103**: 276, 277, *pl. 69, fig. C*, 1919. (The figure illustrates Call's Pond.)

[16] EARLE, K. W., *Report on the Geology of Antigua*. Govt. Printing Office, Leeward Ids., 1923, p. 41.

during my visit to the islands. I did not notice any definite elevated terraces in Anguilla such as are common in the Dominican Republic, Haiti, and Cuba. Since I was particularly looking for them, I think if they were there I should have seen them.

Note: Since this manuscript was written I have received a copy of Prof. W. M. DAVIS's volume "The Lesser Antilles," published by the American Geographical Society, a valuable contribution to the literature on the West Indies, but I do not agree with his opinion that there was a great development of Tertiary atolls in the West Indies.

GEOLOGY.—*The geological age of Tuolumne Table Mountain, California.*[1] OLIVER P. HAY, Washington, D. C.

The writer has had occasion to study the geology and vertebrate paleontology of the Gold Belt of California. In this study he has made use of the works of Whitney, Lesquereux, Diller, Leidy, Knowlton, Holmes, Ransome, Turner, Lindgren, and Sinclair. Lindgren's paper, "The Tertiary Gravels of the Sierra Nevada,"[2] sums up the situation and has been a prime source of information.

Whitney made the brilliant observation that the western slope of the Sierra Nevada had been traversed in the Tertiary by great river valleys which afterward became choked up by flows of volcanic materials. The streams, being thus displaced, were compelled to cut for themselves new courses, the present canyons of that slope. Relying especially on the fossil plants Whitney concluded that the ancient valleys had been filled and obliterated, at the latest, during the Pliocene, and this view was accepted by most persons interested in the subject. The later geologists came to recognize effaced valleys of different ages, some whose beginning extended back into the Eocene or even the late Cretaceous. In fossils coming from some of these volcanic deposits Leidy recognized certain animals which belonged in the Oligocene. Other valleys were seen to have had a later and shorter history.

From the point of view of the vertebrate paleontologist, also perhaps of the anthropologist, Tuolumne Table Mountain is of special interest, for to it and to near-by localities were credited many extinct mammals and many relics of man.

When Whitney sent to Joseph Leidy remains of a wolf from some

[1] Received May 24, 1926.

[2] LINDGREN, Profess. Pap. U. S. Geol. Surv., No. 73, 1911.

of the auriferous gravels Leidy warned him that the animal and the deposits belonged to the Quaternary, but Whitney replied[3] that there were abundant reasons for classing them as Pliocene. In 1899[4] Prof. W. H. Holmes investigated the region about Table Mountain and sought to show that the reports regarding the discovery of relics of early man were untrustworthy; and that if true they would tend to prove the former existence of a Middle Tertiary people. Dr. W. J. Sinclair, writing in 1908,[5] concluded that, if the implements were found as claimed, it would mean that a high type of man was contemporary with the three-toed horse. However, those who consult Lindgren's paper cited above will learn that Table Mountain is a relatively young formation. And here it may be noted that the later geologists have taken arbitrarily as the moment of transition from Pliocene to Pleistocene the end of the eruptive period; admitting, however, that this limit may not coincide with that of the rest of the world.

On his page 215 Lindgren informs us that the river valley in which were planted the roots of Table Mountain had its beginning late in the period of eruptions. The old valleys which had persisted up to this time had already become filled quite to their brims, and a new outlet for the drainage was required. This new watercourse, now called Cataract Channel, eroded rapidly, cutting through the old lava flows and down some hundreds of feet in the bed-rock. Later, new eruptions in the high Sierra occurred which in time clogged the new valley with volcanic mud and finally put a cap of basalt on top of all. This in its turn led to the excavation of the present canyon of Stanislaus River and the conversion of Cataract Channel and its contents into Table Mountain.

A basin of limited area near the village of Columbia was crossed by Cataract Channel.[6] In the deposits of this basin, mostly of volcanic tuffs, the miners found many fossil animals, especially mastodons and elephants, but also horses, a bison, a tapir, and a camel. These are all Pleistocene animals. Some of the horses were identified as *Equus occidentalis*, a species found in the tar pits of La Brea, near Los Angeles. A few miles away, in other auriferous gravels, remains of *Equus pacificus* were discovered, a species known from near San Francisco and from Fossil Lake, Oregon.

[3] Aurif. Gravels, p. 246.
[4] Ann. Rep. Smithson. Inst'n. for 1899, published 1900, pp. 419–472.
[5] Univ. Calif. Pubs. Amer. Arch. Ethn., 7: 129–130.
[6] LINDGREN, op. cit., p. 216.

On his page 266 Whitney published the affidavit of a man who testified that he had taken a mastodon tooth out of a car-load of auriferous gravels coming out of a tunnel from under the basalt of Table Mountain, 200 feet in and at a depth of 125 feet. In 1871[7] Leidy reported having received a fragment of a mastodon tooth which Whitney informed him had been obtained from a depth of 80 feet beneath the basaltic lava. In 1868[8] Prof. B. Silliman became sponsor for the occurrence of a considerable part of a mastodon skeleton beneath the basalt of Table Mountain, 1,600 feet from the mouth of the tunnel. The description of the tusk and teeth indicates that the species was *Mammut americanum*. The tusk was slightly curved, 6 inches in diameter, and 7 feet long. Originally it may have been 10 feet long. Two hindmost molars were each 6 inches long and 3.5 inches wide. The worn penultimate molars were each 4.5 inches long and 2.75 inches wide. Besides this description, sketches of the teeth were sent to Silliman, who wrote that there was no room for doubt that these remains were those of the mastodon. Professor Silliman also secured for Yale College a point of a tusk and an ilium of a mastodon which had been discovered in another tunnel at a distance of 1500 feet from the mouth. He "obtained the plainest possible testimony of eye witnesses to the fact that these bones had been taken from beneath the basalt." As to the species of this specimen we have not the same assurance.

One can hardly doubt that the mastodons found under the basalt were of the same geologic age as fossils found in and around Columbia. These, embracing the two extinct species of horses and a camel, are, in the writer's opinion, of first interglacial age. The mastodons beneath the lava could hardly have existed on the summit of the Sierra range during the cold climate which characterized the close of the Pliocene and the first glacial stage. They cannot be referred to any stage later than the first interglacial, for that would make the basalt too young. Taking into account, then, what Lindgren says about the age of the valley and its volcanic contents, and the nature of the fossils found all around Table Mountain and those buried beneath it, the writer concludes that Table Mountain is a product of the first interglacial stage. It appears probable that the valley had its beginning with the Pleistocene. During the first stage of this epoch, the earliest glacial, the cutting was accomplished. Then eruptions began anew,

[7] Proc. Phila. Acad. Nat. Sci., **23**: 50.
[8] Amer. Journ. Sci., ser. 2, **45**: 378.

the valley was refilled, and the mastodons and the other animals were buried in the debris. Probably at a late time in the first interglacial stage the basalt was belched out and this material crowned the mountain. That this basaltic flow occurred at a somewhat advanced time in the Pleistocene is shown by the presence of remnants of basalt in Stanislaus canyon, 1,500 feet above the river.[9]

In regard to the reputed discovery of human relics in the auriferous gravels the writer believes that Professor Holmes did good service when he pointed out the inadequacy of the evidence furnished. Nevertheless, some of those asserted discoveries of human bones and artifacts in previously undisturbed auriferous gravels may have been real. If so, such remains of man's framework and of his handiwork would prove, not the existence of Tertiary man, but of man of the second stage of the Pleistocene. The case becomes then one of perhaps fifty in our country in which relics of man are so closely associated with early Pleistocene vertebrates that the efforts of some of the ablest geologists have been taxed to cast doubt on the meaning of the association.

BOTANY.—*Notes on Disterigma.*[1] S. F. BLAKE, Bureau of Plant Industry.

The subgenus or section *Disterigma* of *Vaccinium*, proposed by Klotzsch[2] in 1851 for eight South American species, was raised to generic rank almost simultaneously in Niedenzu[3] and Drude[4] in 1889. Drude placed the genus in the tribe *Vaccinieae*, while Niedenzu, on the strength of the leaf anatomy, referred it to the *Thibaudieae*. Hörold, in his treatment[5] of the American *Thibaudieae*, placed *Disterigma* next to *Oreanthes* Benth. and listed 13 species (two of doubtful position), divided into two groups according to the entire or serrate leaf margin, a somewhat variable and unsatisfactory basis for separation. The 22 species now known form a compact group, probably generically distinct from *Vaccinium*, but perhaps later to be united with some one of the related South American genera when the whole tribe is studied monographically. For the present, however, it seems best to retain *Disterigma* as a genus, characterized chiefly by its usually

[9] LINDGREN, op. cit., p. 215.
[1] Received May 29, 1926.
[2] Linnaea **24**: 57. 1851.
[3] Bot. Jahrb. Engler **11**: 160. 18 June 1889. See also pp. 209–210, 247.
[4] In Engl. & Prantl. Nat. Pflanzenfam. **4**[1]: 52. Aug. 1889.
[5] Bot. Jahrb. Engler **42**: 251–334. 1909.

solitary and subsessile generally tetramerous flowers with the ovary embraced by two comparatively large bracts. Of the known species, two occur in Costa Rica and Panama, the others in the Andes from Venezuela and Colombia to Bolivia and Peru.

The genus *Vacciniopsis* Rusby, described in 1893 and compared with *Vaccinium* but not with *Disterigma*, can not be separated from the latter. The original species, *V. ovata*, is distinct from any described *Disterigma*, while the second, *V. tetramera*, described by Rusby in 1920, is apparently identical with *D. dendrophilum* (Benth.) Niedenzu.

The following notes are based on material of *Disterigma* in the National Herbarium, supplemented by a number of specimens lent for study from the Gray Herbarium and the New York Botanical Garden, through the kindness of Dr. B. L. Robinson and Dr. N. L. Britton.

Disterigma elassanthum Blake, sp. nov.

Shrub, with long leafy branches and fastigiate branchlets, these densely rusty-pilose with loosely spreading to ascending hairs; leaves ovate, small, sharply acuminate, entire; flowers axillary, solitary, subsessile; bracts orbicular, at first equaling the ovary; corolla subglobose, about 3.5 mm. long; filaments glabrous, 0.6 mm. long, the anthers 1.6 mm. long, the tubules twice as long as the sacs.

"Shrubby vine," 70 cm. high and more; branches mostly denudate of leaves, with gray fissured bark, grayish-pilose or glabrescent; petioles 0.5–1 mm. long; leaf blades 6–9 mm. long, 2.5–4 mm. wide, rounded or subcordate at base, coriaceous, dull green above, pale beneath, obscurely ciliolate toward tip or glabrous, narrowly pale-margined; pedicels obsolescent, bearing about 2 pairs of bracts, the uppermost pair suborbicular, 2 mm. long, finely ciliolate; ovary glabrous, 1.5–2 mm. long, the calyx limb 1.5 mm. long, the 4 teeth deltoid, acuminate, glabrous; corolla apparently white, depressed-subglobose with broad mouth, 3 mm. long in natural position (4 mm. when teeth are erected), 3.3 mm. thick, the 4 spreading deltoid acute teeth 1.5 mm. long, nearly 2 mm. wide at base; stamens 8, 2 mm. long, the broad glabrous filaments 0.6 mm. long, the anthers 1.6 mm. long (the sacs 0.5 mm. long, the tubules conic, 1.1 mm. long, the slits 0.5–0.6 mm. long).

COLOMBIA: Edge of bog, "Balsillas," on Río Balsillas, Dept. Huila, alt. 2100–2200 m., 3–6 Aug. 1917, *H. H. Rusby & F. W. Pennell* 827 (TYPE no. 1,041,504, U. S. Nat. Herb.; duplicate in Gray Herb.).

In habit and foliage this species closely agrees with the figure of *D. acuminatum* (H. B. K.) Niedenzu. Kunth did not himself see the flowers of that species, but they are described by Weddell, evidently from specimens of the original collection, since no other is cited. According to Weddell the filaments are pilose and about equal the anthers, and the tubules are slightly longer than the anther sacs, characters very different from those shown by the stamens of *D. elassanthum*.

Disterigma leiopodandrum Blake, sp. nov.

Undershrub; branches spreading-hirtellous; leaves elliptic to ovate-elliptic, small, acuminate to a usually obtusish apex, glandular-serrulate; pedicels solitary, 2–11 mm. long, bearing 2 or 3 pairs of bracts, the uppermost orbicular, equaling the ovary at anthesis; calyx lobes deltoid; corolla obovoid-urceolate, 7 mm. long, glabrous except for a few glands outside toward apex; filaments glabrous, 5.2 mm. long, the anthers 2.2 mm. long, the tubules slightly shorter than the sacs.

Caespitose undershrub, fastigiately branched, about 10 cm. high, very leafy; petioles broad, 0.5 mm. long; leaf blades 4.5–6 mm. long, 1.2–2.6 mm. wide, cuneate at base, pale green, coriaceous, often boat-shaped, glabrous above or sparsely hirtellous at base of blade, bearing a few appressed often dark-tipped elongate glands beneath, the lateral veins about 3 pairs, evident or obsolete beneath; flowers solitary, axillary; pedicels spreading-hirtellous, variable in length; uppermost pair of bracts obscurely ciliolate, 3 mm. long, at first equaling or slightly exceeding the ovary, soon surpassed by it; ovary glabrous, 2 mm. long, about equaled by the calyx limb, the 4 teeth deltoid, acute, 1.2 mm. long, obscurely or not ciliolate; corolla obovoid-urceolate, 7 mm. long, about 3.5 mm. thick (as pressed), deep red, above bearing a few subglandular hairs, the 4 teeth triangular, 0.8 mm. long, erect; stamens 8, 7 mm. long, the filaments 5.2 mm. long, glabrous or with about four hairs toward middle, the anthers 2.2 mm. long (the sacs 1.2 mm. long, the broad tubules 1 mm.); berry "white;" seeds obovoid, ridged on one side, favose, brown, 1.2 mm. long.

COLOMBIA: In wet sphagnum on paramo, "Llano de Paletara," Cordillera Central, Dept. El Cauca, alt. 2950–3100 m., 15–17 June 1922, *F. W. Pennell* 6928 (TYPE no. 1,143,622, U. S. Nat. Herb.).

Of the *D. empetrifolium* group, and distinguished particularly by its nearly or quite glabrous filaments.

Disterigma codonanthum Blake, sp. nov.

Shrubby; branchlets spreading-hirtellous; leaves elliptic, small, obtusely acuminate, glandular-serrulate; flowers axillary, solitary, subsessile; bracts equaling or at first surpassing the ovary; corolla campanulate, about 7 mm. long, glabrous; stamens shortly exserted; filaments hirsute, 4.2 mm. long, the anthers 3.2 mm. long, the tubules shorter than the sacs.

Apparently low, fastigiately branched, very leafy; petioles broad, 0.5 mm. long; leaf blades 6–8 mm. long, 1.5–2.5 mm. wide, cuneate-rounded at base, glabrous above, sparsely dark-glandular beneath, coriaceous, pale green, the lateral veins 1–2 pairs, often evident beneath; pedicels about 1 mm. long, bearing about 2 pairs of bracts, the uppermost pair (subtending the ovary) suborbicular, many-nerved, 3.5 mm. long, obscurely ciliolate; ovary glabrous, about 2.5 mm. long, the calyx limb 3–3.5 mm. long, its 4 teeth about 2.6 mm. long, 1.5 mm. wide at base; corolla (red ?) 7 mm. long (with teeth erected), about 5 mm. thick, glabrous, the 4 teeth deltoid, reflexed, 3 mm. long and wide; stamens 8, 6.8 mm. long, the filaments 4.2 mm. long, spreading-hirsute except toward base, the anthers 3.2 mm. long (the granulose sacs 2 mm. long, the rather definitely distinguished tubules 1.2 mm. long, the linear-elliptic pores 0.7 mm. long).

ECUADOR: Ecuadorian Andes, 1857–9, *R. Spruce* 5138 (TYPE in Gray Herb.; photograph and fragment, U. S. Nat. Herb.).

The type was distributed as a *Vaccinium*, under a manuscript name that has since been used in that genus for another species. *D. codonanthum* is distinguished from all except *D. pernettyoides* (Griseb.) Niedenzu by its broadly campanulate corolla. In *D. pernettyoides* the corolla is considerably larger (1–1.3 cm. long), the stamens are not exserted, and the tubules are longer than the anther sacs.

Disterigma pentandrum Blake, sp. nov.

Undershrub; branchlets spreading-puberulous; leaves ovate to elliptic, small, obtuse, entire, thick and essentially veinless, marginate; flowers axillary, solitary, subsessile, 5-merous; bracts slightly surpassing ovary, oval-ovate, acutish, ciliate; calyx segments triangular, considerably longer than ovary, glandular-ciliate; corolla cylindric-urceolate, 10 mm. long, sparsely glandular outside above; stamens 5, the filaments 3.2 mm. long, pilose, the anthers 5.2 mm. long, the tubules somewhat exceeding the sacs.

Branches up to 28 cm. long, finely gray-puberulous, leafy; petioles 1 mm. long or less; leaf blades 7–12 mm. long, 4–7 mm. wide, obtuse or rounded, rounded at base, fleshy-coriaceous, strongly wrinkled on both sides when dry but without definite veins, glabrous, light green above, pale or brownish beneath, with thickened pale margins; pedicels obsolescent, bearing about 3 pairs of crowded bracts, the uppermost (subtending the ovary) 2.2 mm. long; ovary about 1.8 mm. long, (3- or) 5-celled, glabrous; calyx limb 2.8 mm. long, the 5 lobes triangular, acuminate, 2.2–2.6 mm. long, 1 mm. wide at base, erect; corolla (reddish ?) 10 mm. long, 3 mm. thick, fleshy, glabrous inside, the 5 erect triangular-oblong obtuse teeth 1.8 mm. long; stamens 7.8 mm. long; filaments not at all connate, pilose inside except toward the broadened base; anther sacs 2.4 mm. long, passing gradually into the conic tubules, these 2.5–2.8 mm. long, the slits 2.2–2.4 mm. long.

ECUADOR: Vicinity of Huigra, mostly on the Hacienda de Licay, 3 Sept. 1918, *J. N. & G. Rose* 22512 (TYPE no. 1,022,164, U. S. Nat. Herb.); vicinity of La Chonta, 16–17 Oct. 1918, *Rose, Pachano, & Rose* 23470.

In every character except its pentamerous flowers this plant is clearly a *Disterigma*, and since *D. ovatum* shows both 4- and 5-merous flowers (with 8 or 10 stamens), *D. pentandrum* may be received into the same genus. It is distinguished from all other species of the genus by its 5 stamens. In a flower of no. 23470 dissected the ovary was 3-celled, although the other floral parts were pentamerous. In Hörold's key to genera this species run to *Oreanthes* Benth., because of its 5 stamens. In that monotypic genus the filaments are connate into a tube, and the corolla is described as 10 lines long.

DISTERIGMA DENDROPHILUM (Benth.) Niedenzu.

Vaccinium dendrophilum Benth. Pl. Hartw. 219. 1846.
Disterigma dendrophilum Niedenzu, Bot. Jahrb. Engler 11: 224. 1889.
Vacciniopsis tetramera Rusby, Descr. New S. Amer. Pl. 77. 1920.

The unique type of *Vacciniopsis tetramera* in the Columbia University Herbarium, sent for examination by the kindness of Dr. N. L. Britton, appears to belong to *D. dendrophilum*. The type collection of that species (*Hartweg* 1204) has not been examined, but *Spruce* 5403 (in the Gray Herbarium), distributed under that name, is evidently the same as Rusby's plant, although the anthers are longer. *Rusby* 2026, from Bolivia, is identical with the type of *V. tetramera*, and inseparable from *Spruce* 5403.

Disterigma pachyphyllum (Hemsl.) Blake.

Vaccinium pachyphyllum Hemsl. Biol. Centr. Amer. Bot. **2**: 275. 1881.

This Costa Rican species is related to *D. alaternoides* (H. B. K.) Niedenzu, and Hörold's record of that species from Central America doubtless refers to it.

Disterigma ovatum (Rusby) Blake.

Vacciniopsis ovata Rusby, Bull. Torrey Club **20**: 434. *Pl. 170.* 1893.

The flowers in this species, the type of the genus *Vacciniopsis*, are both 4- and 5-merous on the same specimen, and the plant is clearly a member of the genus *Disterigma*. Its closest ally is *D. popenoei* Blake, of Ecuador, which has more strongly 3-nerved leaves, more numerous flowers (about 6 in a fascicle), narrower white corollas rather densely spreading-puberulous outside, and different stamens. In *D. popenoei* the filaments are 5 mm. long and pilose on both sides except toward base, the anther sacs are 1 mm. long, and the tubules 2 mm. In *D. ovatum* the filaments are 2.8 mm. long, pilose only above the middle, the anther sacs 1.5 mm. long, and the tubules 1.7 mm. In Dalla Torre & Harms' Index, *Vacciniopsis* is placed in a different tribe (*Thibaudieae*) from *Disterigma*. It is not mentioned in Hörold's revisionary treatment of the American representatives of that tribe.

BOTANY.—Tetrastylis, *a genus of Passifloraceae.*[1] ELLSWORTH P. KILLIP, U. S. National Museum.

Tetrastylis, a genus of Passifloraceae, was established by Barbosa Rodriguez[2] in 1882, and to it was assigned a single Brazilian species, *Tetrastylis montana* Barb. Rodr. The description of the plant was very complete, and was accompanied by an excellent illustration. The principal points of difference between this genus and its nearest relative, *Passiflora*, as noted by Barbosa, were:

TETRASTYLIS	PASSIFLORA
1. Four styles.	1. Three styles.
2. Gynophore curved.	2. Gynophore straight.
3. Stamen filaments united beyond gynophore, only the extremities free.	3. Stamen filaments free from gynophore to extremities.
4. Four placentae.	4. Three placentae.

In the *Natürlichen Pflanzenfamilien*[3] Harms recognized *Tetrastylis* as a valid genus, placing it immediately before *Passiflora*. In the *Index Kewensis* it was given as a synonym of *Passiflora* and *Tetrastylis montana* was identified with *Passiflora ovalis*, a plant figured by

[1] Published by permission of the Secretary of the Smithsonian Institution. Received May 17, 1926.

[2] Rev. Engenharia **4**: 260. 1882.

[3] P. 86. 1894.

Velloso in the Flora Fluminensis. In the first supplement to the *Natürlichen Pflanzenfamilien*[4] Harms created the section *Tetrastylis* in the genus *Passiflora* for this plant. Several collections of this species have been made, and these have generally been distributed as *P. ovalis* Vell.

A few years ago several specimens of a Costa Rican plant, collected by Mr. H. Pittier, were distributed by the Instituto Físico-Geográfico Nacional of Costa Rica under the name *Passiflora adenopoda* DC. The specimens resemble *P. adenopoda* only in general leaf shape; the structure of the flower is essentially identical with that of *Tetrastylis*, that is, there are four styles, four placentae, and a curved gynophore, and the stamens are monadelphous *beyond* the gynophore. Several specimens of this same plant have recently been collected in Costa Rica by Mr. Paul C. Standley. This Costa Rican material represents a species, apparently undescribed, closely related to the Brazilian plant of Barbosa Rodriguez. The four details mentioned above seem to the writer of generic, rather than subgeneric, importance, and *Tetrastylis* should undoubtedly be maintained as a distinct genus.

A plant from Siam recently described by Gagnepain[5] as *Passiflora octandra* is said to have 3, or often 4, styles, 3, or often 4, placentae. Other unusual features are four or five sepals, four or five petals, and six or eight stamens. Except for this plant, which may well represent a distinct genus, and the two species of *Tetrastylis*, the writer knows of no plants of this relationship with four styles and placentae.

A description of *Tetrastylis* and the two known species follows:

Tetrastylis Barb. Rodr. Rev. Engenharia **4:** 260. 1882.

Passiflora Sect. *Tetrastylis* Harms, Nat. Fam. 1. Aufl. 1. Nactr. 253. 1897.

Shrubby or herbaceous vines, bearing simple, axillary tendrils; stipules present; leaves alternate, petiolate; flowers in axillary racemes, or solitary or in pairs in the axils of the leaves; flower tube short, patelliform; sepals 5; petals 5, alternate with the sepals, inserted at the margin of tube; corona filamentose; operculum membranous; gynophore elongate, curved; stamens 5, the filaments united beyond gynophore into a broad membrane, only the extremities free, monodelphous; anthers oblong, bifid at base; ovary oblong, stipitate, obtusely 4-angled; ovules 4-ranked on 4 parietal placentae.

KEY TO SPECIES

Flowers in axillary racemes; leaves entire, coriaceous; stipules filiform, soon deciduous; petioles glandular at base; woody vine (Brazil). 1. **T. ovalis**

Flowers solitary or in pairs in the axils of the leaves; leaves 3-lobed, membranous; stipules semi-ovate, persistent; petioles glandular at middle; herbaceous vine. (Costa Rica) ..... 2. **T. lobata**

[4] P. 256. 1897.

[5] Bull. Mus. Hist. Nat. Paris **25:** 128. 1919.

1. **Tetrastylis ovalis** (Vell.) Killip, comb. nov.

Passiflora ovalis Vell. Fl. Flumin. **9**: *pl. 75*. 1827 (figure only); M. Roemer, Fam. Nat. Syn. **2**: 168. 1846.

Passiflora silvestris Mast. in Mart. Fl. Bras. **13**[1]: 620. *pl. 127*. 1872, not *Passiflora silvestris* Vell.

Tetrastylis montana Barb. Rodr. Rev. Engenharia **4**: 260. 1882.

Woody vine; glabrous throughout; stems terete, longitudinally sulcate, suberose below; stipules setaceous, 8 to 10 mm. long, soon deciduous; petioles 2.5 to 4 cm. long, biglandular at base, the glands orbicular, about 1.5 mm. in diameter, sessile; leaves elliptic or elliptic-oblong, 6 to 10 cm. long, 3 to 5.5 cm. wide, not lobed, abruptly acuminate at apex, acutish at base, entire, usually cartilaginous at margin, 1-nerved (principal secondary nerves 7 or 8 pairs, arcuate), conspicuously reticulate-veined, coriaceous, sublustrous; flowers in axillary racemes up to 75 cm. long, the peduncles short, about 1 cm. long, stout, 2-flowered, the pedicels 1.5 to 4 cm. long, articulate above middle; bracts and bractlets setaceous, 1 to 2 mm. long, soon deciduous; flower tube 3 to 5 mm. long; sepals oblong, 2.5 to 3 cm. long, 0.5 to 0.7 cm. wide, obtuse, ecorniculate, subcoriaceous, dull red without (when dry), paler within, longitudinally streaked with red; petals oblong or lance-oblong, 1.5 to 2 cm. long, 0.3 to 0.5 mm. wide, obtuse, membranous, whitish, longitudinally streaked with red both without and within; corona filaments narrowly liguliform, in 2 series, the outer about 1 cm. long, the inner half as long; operculum membranous, closely plicate, incurved, crispate; limen annular, fleshy; gynophore about 2 cm. long; ovary oblong; fruit (according to Velloso) oblong, about 10 cm. long, 6 cm. wide; seeds obovate, truncate at apex.

Specimens examined (all Brazil):

Rio de Janeiro, *Glaziou* 7859 (Paris, Berlin, Copenhagen), 8269 (Berlin, Copenhagen), 14854 (Paris, Berlin, Geneva, Kew, Copenhagen), 14873 (Paris); *Peckholt* 7 (Berlin); *De Moura* 503 (Berlin). Bahia, *Blanchet* 1708 (British Museum). Without definite locality, *St. Hilaire* 1689 (Paris).

The nomenclature pertaining to this species is somewhat involved. Velloso's figure was unaccompanied by any description or explanatory notes, and under the rules of nomenclature does not constitute valid publication. Roemer, however, in his elaborate monograph of Passifloraceae, gives a detailed description of Velloso's plate, and the species must be considered to date from this publication in 1846. Masters' treatment of the species in the Flora Brasiliensis[6] is a curious one. Here species no. 77 is given as "Passiflora silvestris Vell." and Velloso's plate 74, bearing this name, is cited. The description which Masters then gives of this species applies in general, however, to Velloso's plate 75 (*P. ovalis*), and the figure with which Masters illustrates "Passiflora silvestris" (plate 127) agrees almost exactly with Velloso's *P. ovalis*, and bears no resemblance to the plate of *P. silvestris* of Velloso. The inflorescence as shown by Masters' plate is an elongate raceme with 2-flowered peduncles, and the leaves are narrowed at the base, with the petioles biglandular. The detailed enlargement of the flowers shows four styles but a *straight* gynophore with the staminal structure as in true *Passi-*

[6] 13[1]: 620. *pl. 127*. 1872.

flora. This conventionalized flower sketch I believe was made from two different plants, one true *Tetrastylis ovalis*, the other some unknown species of *Passiflora* of the *Granadilla* relationship. This solution is also suggested by the specimens which Masters cites under his "*Passiflora silvestris*." The first mentioned is "Velloso," the specimen not being seen by Masters. The second is "Luschnath." This specimen I did not see at any of the European herbaria visited, and at Kew it is represented only by a sketch of the flower. This has *three* styles and a straight gynophore. Accompanying the sketch is a note by Masters "P. sylvestris St. Hil.?" The third specimen cited is "Prov. Minas Geraës, St. Hilaire 1689." This specimen, which I saw at Paris, is *Tetrastylis ovalis*.

Finally, as to "Passiflora ovalis Vell." Masters merely lists this among certain doubtful species, stating that only a fruiting specimen was figured.

The identity of *Passiflora silvestris* Vell. (plate 74) I have not fully established. It represents a plant closely related to *Passiflora jileki* Wawra if not that species.

2. **Tetrastylis lobata** Killip, sp. nov.

Stem stout, triangular, grooved, glabrous; stipules in pairs, semi-ovate, 5 to 15 mm. long, 3 to 8 mm. wide, aristate, entire; petioles 3 to 8 cm. long, canaliculate above, hispidulous, bearing near middle 2 subsessile saucer-shaped glands, a second pair occasionally present at base of blade, the glands 1 to 2 mm. in diameter; leaves 10 to 15 cm. long (along midnerve), 12 to 20 cm. wide (between apices of lateral lobes), 3-lobed half to two-thirds the length of the blade (lobes variable, oblong, oblong-lanceolate, or broadly ovate-lanceolate, 2.5 to 6 cm. wide, acuminate or acute), cordate, 3-nerved, entire or slightly undulate, membranous, dark green and minutely hispidulous with hooked hairs above, glabrous, (occasionally slightly scabrous), and mottled with dull dark red beneath; peduncles solitary or in pairs, 2 to 3.5 cm. long, glabrous or sparingly hispidulous; bracts setaceous, 2 to 3 mm. long, borne on lower half of peduncle; flowers 3.5 to 6 cm. wide, the tube patelliform, about 3 mm. long; sepals oblong-lanceolate, 1.5 to 2.5 cm. long, 0.4 to 0.8 cm. wide, sparingly hispidulous and green without, glabrate and white, or pale rose, streaked longitudinally with violet within, terminating in a horn about 2 mm. long; petals ovate-lanceolate, 0.8 to 1.5 cm. long, 0.5 to 0.7 cm. wide, obtuse, streaked longitudinally with violet on both faces; corona filaments in a single series, filiform, narrowly ligulate, 1 to 2 cm. long; operculum membranaceous, deep red, strongly plicate, incurved up to 5 mm. high, minutely denticulate; nectar ring annular, less than 0.5 mm. high; limen membraneous, 1 to 2 mm. high, incurved, crenulate; gynophore about 1 cm. long; stamens united to within 3 mm. of their tips, forming a membranous androecium, the upper portion free from the gynophore, about 2.5 mm. long, the lower portion closely sheathing the gynophore; ovary narrowly ovoid, obtuse, tapering at base, glabrous; styles clavate, 4.5 mm. long, recurved; stigmas saucer-shaped; fruit obovoid, about 10 cm. long, 3 cm. in diameter, green, white-spotted; seeds obovate.

Type in the U. S. National Herbarium, no. 1,251,085, collected at La Hondura, Province of San José, Costa Rica, altitude 1200–1500 meters, March 9, 1926, by Paul C. Standley (no. 51917).

Additional specimens examined (all Costa Rica):

Finca de Chirripó, Plains of Zent, altitude 200 meters, *Pittier* 16055 (U. S. N. M., Brit. Mus.), 16100 (Brit. Mus.). Tilarán, altitude 750 meters, *Valerio* 14 (U. S. N. M.). Vicinity of Orosi, Province of Cartago, *Pittier* 16026 (U. S. N. M.); *Standley* 39673, 39720, 39793. Santa María de Dota Province of San José, *Standley* 41796. El Muñeco, on Río Navarro, Province of Cartago, *Standley* 51389. La Estrella, Province of Cartago, *Standley* 39352. Quebrada Serena, southeast of Tilarán, Province of Guanacaste, *Standley* 46140 (all U. S. N. M.).

Two of these specimens (*Pittier* 16055 and *Valerio* 14), have leaves less deeply lobed than are those of the type, and the pubescence is rather denser. The general appearance of Standley's 46149 is quite different, the leaves drying a lighter green and the lateral lobes being much reduced. The flowers of all of the specimens here cited seem the same, and the differences in vegetative characters are no greater than in many species of the family.

This plant is not to be confused with *Ceratosepalum micranthum* Oersted[7] (later reduced to *Passiflora ceratosepala* Mast.). *Ceratosepalum* was segregated from *Passiflora* mainly on the basis of horned sepals. Among several specimens of Passifloraceae sent me by the Universitetets Botaniske Museum, Copenhagen, for study were two sheets labeled "Ceratosepalum" in Oersted's handwriting, which evidently are type material of *Ceratosepalum micranthum*. They prove to be *Passiflora adenopoda* DC., a fairly common species ranging from Mexico to northwestern South America.

ANTHROPOLOGY. *The fundamental principles of Algonquian languages.*[1] TRUMAN MICHELSON, Bureau of American Ethnology.

The grammatical processes are prefixing, suffixing, reduplication of various types, vocalic change, and composition. All objects are classified as animate and inanimate. Singular and plural are distinguished; as also the first person plural exclusive and inclusive; difference and identity of third persons are carefully kept apart by grammatical devices. In the verb there are frequently two stems, and sometimes more. Of these those which under no circumstances can occur in the initial position are very few in number. When two stems, both of which can occur in the initial position, are combined in a single compound, it is quite conventional as to which precedes or follows. The phonetic changes resulting from such combinations are relatively few and are of a simple character. It should be noted that a number of stems indicating parts of the body occur in the second position only.

[7] OERSTED, Rech. Fl. Amer. Centr. 18. *pl. 17.* 1863.

[1] Summary of an address given before Section L of the American Association for the Advancement of Science, January 3, 1925. Received May 26, 1926.

And it should be stated that the auxiliaries are few in number and occur in the second position only, and frequently are entirely distinct according to whether the subject is animate or inanimate. The number of moods is very great. The subject pronouns of the independent mood are clearly related to, and in some cases are identical with, the possessive pronouns, and are partly prefixed, partly suffixed, partly both. Some of the objective pronouns of the independent mood are the same as some of the subordinate moods, and are suffixed. The inclusive form in this mood (and others) is clearly related to the second person plural. The forms of the independent mood with the third person animate, singular and plural, as subjects and the first and second person singular, the inclusive and exclusive, and the second person plural as objects are really passives in construction. All the pronouns of the subordinate moods are invariably suffixed. The objective pronouns are largely the same in the various subordinate moods while several of the subjective pronouns are fundamentally different. Yet in many cases the objective and subjective pronouns are so fused, and at times even modal elements with them, that analysis into the constituent elements is not possible. A participial is formed by changing the stem vowel of the first vowel of the initial stem; the pronominal elements in this case are obviously derived from other sources with but slight changes. The complexities of this mood, however, have not been thus far adequately treated. The following voices are distinguished: active, middle, passive, reflexive, and reciprocal. The last two are formed by special suffixes, but the ordinary intransitive verbal pronouns are used. At least two passives are common, one where the agent is either expressed or understood, the other where the agent is not expressed and is indefinite. The pronominal elements of the last, in the case of the independent mode, are allied partially to the ordinary intransitive verbal pronouns. Other passives apparently exist, but their exact function is not accurately known. One appears to be very indefinite and to occur only with an indefinite subject. Every active, middle, and passive verb (with a few exceptions) requires an instrumental particle showing by what the action was done, e.g., by the hand, by the foot, by heat, by cutting, etc. The middle voice employs the ordinary intransitive verbal pronouns with these particles. From what has been said it is clear that in some Algonquian languages the verbal pronominal elements theoretically must run into the thousands. These instrumental particles are comparatively few in number (in Fox about forty), and

usually differ in form according to whether the logical object is animate or inanimate; in the case of the middle voice the subject (animate or, rarely, inanimate) determines the choice. It should be noted that often these particles are purely formal, having lost their original significance; in such cases it must be known by rote as to which sets go with any given verbal stem. The instrumental particles can be combined with initial stems, and follow them if there is no second stem; if there is a second stem (whether wholly non-initial or one that may occur in the initial position in another verbal compound), they follow this. The typical Algonquian verb in subordinate moods would be: first stem, second stem, instrumental particle, objective pronoun, subjective pronoun, modal element. Temporal relations in some dialects are expressed by what for convenience may be termed prefixes, though there are indications that some are strictly not these, in others by combining initial stems. Reduplication of various types occurs, to express ideas of intensity, duration, distribution. When the whole stem is not reduplicated, a long ī of the first syllable of the initial stem (which alone can be reduplicated) is replaced by ā; under similar conditions ō also by ā. The structure of nouns follows the general arrangement of verbs, but there are some suffixes with generic meanings. It may be added that abstract nouns are extremely common. A general, vocative, locative, and obviative (and in some dialects a sur-obviative) case are distinguished. The independent pronouns are patently related to the possessive pronouns. The demonstrative pronouns express such ideas as near and visible, removed but visible, past time, etc. What has been said above applies especially to the Eastern-Central dialects; Blackfoot and Arapaho have specialized in opposite directions; so we may be sure that neither presents a primitive Algonquian grammar. Secondary phonetic changes and some specializations have in some instances obliterated the principles enunciated above in certain of the Eastern dialects; but in almost all cases we may show by comparative methods what originally existed.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

938TH MEETING

The 938th meeting was held at the Cosmos Club on Saturday evening, April 17, 1926. The meeting was called to order by Vice-President AULT at 8:15, with 32 persons in attendance.

The program for the evening consisted of two papers. The first by H.

L. DRYDEN was on the *Measurement of the performance of desk fans*, and was discussed by Messrs. BREIT, DICKINSON, PAWLING, TUCKERMAN and HUMPHREYS.

The common method of measuring the output of desk and bracket type electric fans consists in the measurement of the velocity distribution along one or more diameters by means of a Pitot tube and inclined gauge or equivalent device, the results being integrated to give the total volume of air flowing. These measurements were shown to be subject to a systematic error due to the angular inclination of the airflow to the Pitot tube. A general description was given of the type of airflow and of the principles involved in the cooling action of the fan. Various quantities which have been suggested as measures of the output were discussed, including volume per unit time, momentum per unit time, and energy per unit time. As a result the momentum per unit time was suggested as the best criterion of cooling power since (1) it is sensibly constant at all distances from the fan; (2) it is a satisfactory compromise between several theoretical considerations; and (3) it is readily and accurately measurable by the thrust reaction on the fan. Methods of measurement of the thrust were described and a particular form of instrument was suggested for convenient use. (*Author's abstract.*)

The second paper on the program was by W. W. COBLENTZ on *Impressions of the Sumatra eclipse expedition*, and was illustrated by lantern slides. It was discussed by Messrs. HUMPHREYS and AULT.

The speaker was one of a party of four, under the leadership of Dr. H. T. Stetson of the Astronomical Laboratory, Harvard University, that went to Sumatra to observe the solar eclipse of January 14, 1926. Leaving San Francisco in November, 1925, after spending a month in the eclipse camp at Benkoelen, Sumatra, they returned by way of the Suez Canal and Europe in March, 1926.

After discussing various factors that affect eclipse observations the speaker exhibited an extensive series of lantern slides of scenes along the route as well as in the eclipse camp.

There were eight expeditions in the field to make observations on the solar eclipse; one on the east coast of Sumatra, one in the center of the island, and six in Benkoelen on the west coast. Only the latter expedition had good weather during most of the time of totality.

In view of the numerous factors that enter into the success of such an undertaking (the weather, and health of the members, unforeseen accidents, etc.), it seems desirable to consider the results obtained by all the parties concerned, as a whole; and when so judged the results obtained were a success.

The Harvard-Bureau of Standards eclipse party had six projects; including thermopiles for measuring the radiation of the corona, a lumenometer for measuring the brightness at totality, a silvered quartz lens camera for photographing the corona in ultra light, and two photographic methods for obtaining the color index. The lumenometer measurements show that the normal illumination at totality was brighter than that of the eclipse of January 24, 1925.

The speaker had an opportunity to study the native fireflies and glow worms in Sumatra, and vegetation on the moving sands in Egypt, the latter being of interest in connection with the question of variation in coloration on the surface of Mars. Unusual phenomena, such as the "green flash" at sunset, and the sheen over the ocean from the zodiacal light, were commented upon in concluding the address. (*Author's abstract.*)

An informal communication on *Gravity variations due to the moon* was presented by Mr. A. S. HAWKESWORTH.

939TH MEETING

The 939th meeting was held at the Cosmos Club on Saturday evening, May 1, 1926. The meeting was called to order by President BOWIE at 8:16, with 31 persons in attendance.

The program for the evening consisted of two papers. The first by W. J. PETERS was entitled *The 27-day interval in earth currents*. It was illustrated, with lantern slides and was discussed by Dr. BAUER.

Dr. Chree and others have shown by statistical investigations the recurrence of average high and average low values on the 27th day after days of selected maximum and minimum in long unbroken records of magnetic measures, such as the international character numbers, the daily ranges in magnetic elements. The high correlation found by Dr. Bauer between the variations, in terrestrial magnetism, atmospheric electricity, and earth-currents indicates the desirability of applying the same statistical method of investigating the 27 day recurrency to those related phenomena.

The subject of this paper is a description of the process as applied to the earth-current observations published in the bulletins of Ebro Observatory in Spain between 1910 and 1924 inclusive and the exhibition of the results.

The daily ranges in the potential of the northerly-extending line, expressed in millivolts per kilometer were transferred by adding machine to strips of paper, the values for each day following one another in regular order without any intermissions excepting the missing observations. According to the usual practice the 5 highest and the 5 lowest values of each month were selected and the particular day on which each value occurs was designated n. They were marked on the strips, after which it became a simple matter to pick out by means of a device designed by Mr. C. C. Ennis the values that occur on any day desired, the $(n + r)$th day, following or preceding the days, nth days, on which the selected values occur.

The values of r were taken from -2 to $+2$ inclusive, in order to bring out the mean character of the selected maximum or minimum values, and from $+23$ to $+32$ inclusive not only to show the character of corresponding mean values on and around the 27th day but also to develop any other recurrency interval that might exist within these limits.

Results were given for the following periods: 1910–1914, which covers the earliest published records of the Observatory; 1915–1919, which includes the year of sunspot maximum, 1917, and the year of magnetic maximum, 1919; 1922–1924, which covers the period after the intermission of one year, 1921, during which the apparatus was overhauled, up to the most recent published results; 1910–1920, which covers the period of another investigation; and 1910–1924, which includes all data available. The paper will appear in *Terrestrial Magnetism*. (*Author's abstract.*)

The second paper was by E. O. HULBURT on *The spectrum of hydrogen in the stars and in the laboratory*. It was illustrated with lantern slides, and was discussed by PAWLING, BREIT, LAPORTE, and HUMPHREYS.

The Balmer series of hydrogen, the simplest series of the simplest of terrestrial elements, finds its most striking development in the spectra of the stars and in the "flash spectrum" of the sun. As many as thirty to thirty-five lines of the series are observed in the light from these extra-terrestrial sources. The characters of the lines themselves vary greatly

in the different spectra, being bright (emission), dark (absorption), narrow, broad, singly, doubly and triply reversed, etc. The production of these lines and their variations with the relatively weak apparatus of the terrestrial laboratory has been accomplished only in part. The laboratory investigations have, however, contributed definite knowledge of the physical conditions in the stellar atmospheres, and further investigations offer great promise.

The laboratory observations of the emission series to the twentieth Balmer line and of the absorption series to the tenth line indicate that great expanses of glowing hydrogen at low pressures are necessary for the full development of the series as seen in the stellar spectra. The Balmer lines broaden very greatly with pressure, current density, foreign gases, etc. Studies of the intensity distribution across the individual broadened lines have led to the conclusion that the broadening is caused by the electric fields of the ions and electrons of the radiating gas. This theory of broadening is applied to the wide hydrogen lines of the stars. From the observed widths of these together with the Saha theory of temperature ionization the conclusions are indicated that the pressures in the stellar reversing layers are low and that there may be many electrons in these layers.

Doubly reversed Balmer lines are observed in the laboratory, but as yet no triple reversals. Stellar atmospheres which give rise to the double and triple reversals may be pictured with some certainty. The cause of the asymmetric reversals observed in some stellar spectra can not be said to be definitely known. (*Author's abstract.*)

H. A. MARMER, *Recording Secretary.*

ANTHROPOLOGICAL SOCIETY

596TH MEETING

At the 596th meeting of the Anthropological Society on March 16th, W. H. JACKSON, photographer to the Hayden Geological Surveys, 1870–79, reviewed his experiences of fifty years ago among cliff ruins and Pueblo villages in Colorado and New Mexico, illustrating his subject with slides from original photographs. While engaged in photographing in the San Juan Mountains, in 1874, a chance meeting with prospectors who told of some wonderful cliff dwellings not far from their camp on the Rio La Plata led to the discovery, or more properly the first published account, of the Mesa Verde ruins. (Letter to the New York Tribune, November 3d by Ernest Ingersoll.) Following their advice that something worth while might be found in that region, Mr. JACKSON left his main party in camp at Baker's Park and with Mr. INGERSOLL, and two packers, made a hasty side trip to the miners' camp where he met JOHN MOSS, who had traveled extensively over the southwest and who volunterred to guide the party through Mancos Canyon in the Mesa Verde, where he said the best examples of ancient cliff dwellings were to be found. On a six day ride taking in the Mesa Verde, the McElmo canyon, and the Hovenweep valley, many of these ruins were discovered and photographed, but the greatest and most interesting group of all, now the main feature of the Mesa Verde National Park, was not discovered until fourteen years later. The results of this first expedition among the cliff dwellings were of such interest that exploration was continued the following year into Utah and Arizona. Mr. W. H. HOLMES also led a party into this region, which, while primarily engaged in geological work, devoted much time to archeological research, paying particular attention to the towers of the San Juan Valley. Mr. JACKSON'S party followed the San Juan

River to the Chinle, and thence to the Hopi pueblos. Returning northwards they visited the Abajo and LoSal Mountain region and then followed the Montezuma Canyon back to the starting point. Many interesting cliff, cave, and town ruins were discovered and photographed, including nearly every canyon, mesa or valley throughout the whole region containing evidences of prehistoric occupation. The Southern Utes, as well as tribes farther west, were troublesome this year, Mr. GARDNER's topographical party being attacked near the Abajo Peaks by a large party, with the loss of three animals and all his camp equipment. Mr. HOLMES' party came near losing all its animals, and Mr. JACKSON also had frequent encounters, but without loss. In 1877 an extended trip was made through New Mexico to the Hopi pueblos in Arizona, during which Mr. JACKSON made a detailed study of the Chaco Canyon ruins, and with the reports which followed, concluded his archeological work for the Survey.

SCIENTIFIC NOTES AND NEWS

Dr. WILLIS T. LEE, geologist of the United States Geological Survey, known to the public through his recent scientific studies and surveys of the Carlsbad and other noted caverns of the country, died at his home in Washington on June 17, in his sixty-second year.

Dr. T. A. JAGGAR, director of the Hawaiian Volcano Observatory of the U. S. Geological Survey, gave an illustrated lecture at the Interior Department on June 12 on *The recent eruption of Mauna Loa.*

Dr. N. L. BOWEN of the Geophysical Laboratory, Carnegie Institution of Washington, sailed for England on June 5, to spend the summer in field work on the igneous rocks of the British Isles, in company with several British petrologists.

JOHN W. VANDERBILT, S. SPENCER NYE and MARTIN J. BUERGER have been appointed junior geologists in the U. S. Geological Survey and have been assigned field work in the west.

B. S. BUTLER and T. S. LOVERING of the U. S. Geological Survey have been assigned to the State of Colorado to begin coöperative geological surveys in that State designed to aid in the development of its metalliferous mineral resources. The research may extend over a number of years.

The new officers of the American Geophysical Union as elected for the period July 1, 1926 to June 30, 1929, at the annual meeting of the Union in April last, are: Chairman, H. S. WASHINGTON; Vice-Chairman, G. W. LITTLEHALES. (J. A. FLEMING continues as General Secretary through June 30, 1928.) The newly elected officers of sections for the corresponding period are: (*a*) Geodesy—Chairman, WILLIAM BOWIE; Vice-Chairman, F. E. WRIGHT (W. D. LAMBERT continues as Secretary through June 30, 1928); (*b*) Seismology—Chairman, L. H. ADAMS; Vice-Chairman, N. H. HECK (D. L. HAZARD continues as Secretary through June 30, 1928); (*c*) Meteorology—Chairman, H. H. KIMBALL; Vice-Chairman, G. W. LITTLEHALES; Secretary, A. J. HENRY; (*d*) Terrestrial Magnetism and Electricity—Chairman, N. H. HECK; Vice-Chairman, J. H. DELLINGER; Secretary, J. A. FLEMING; (*e*) Oceanography—Chairman, T. WAYLAND VAUGHAN; Vice-Chairman, G. T.

RUDE; Secretary, AUSTIN H. CLARK; (*f*) Volcanology—Chairman, T. A. JAGGAR, Jr.; Vice-Chairman, F. E. WRIGHT (R. B. SOSMAN continues as Secretary through June 30, 1928).

The United States Geological Survey has established a Section of Volcanology in the Geologic Branch, effective July 1, of which T. A. JAGGAR, Jr., will be Volcanologist in charge.

Mr. KIRK BRYAN of the United States Geological Survey has been appointed Lecturer in Physiography at Harvard University for the year 1926–27.

N. L. WIMMLER has been appointed mining engineer and F. W. HOLZHEIMER associate mining engineer in the U. S. Geological Survey. They will make investigations in Alaska.

A. M. PIPER has been appointed assistant geologist in the Water-Resources Branch of the U. S. Geological Survey, and will be assigned to ground-water investigations.

H. D. MISER, who has been temporarily State Geologist of Tennessee since September 1, 1925, has returned to the U. S. Geological Survey and has been appointed Geologist in charge of areal geology, in the Geologic Branch, as successor to Sidney Paige, resigned.